REMARKS

This is intended as a full and complete response to the Office Action dated August 19, 2003, having a shortened statutory period for response set to expire on November 19, 2003.

Claim Rejections Under 35 U.S.C. § 102(b)

Claims 1-7 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,804,820 to Michael L. Evans et al (*Evans '820*). Applicant respectfully traverses the rejections.

Evans '820 discloses a system for determining density of earth formation. The *Evans '820* system detects both *neutron and* gamma ray signals which are analyzed and *combined* to determine the density of an earth formation. This is recited in lines 8-10 of the abstract, and taught throughout the disclosure. It is emphasized that the *Evans '820* apparatus comprises *both* neutron *and* gamma ray detectors, *both* neutron *and* gamma ray signals are measured, and *measures of both neutron and gamma ray signals are required to obtain a measure of formation density*.

The instant system is also a system for measuring earth formation. The instant system, however, uses only gamma ray detectors, and only gamma ray signals are (and can) be used to obtain a measure of formation density. The instant invention is similar to the *Evans '820* system *only* in that both measure formation density. Basic measurement principles differ. Apparatus differs. Data processing differs.

The *differences* in *Evans '820* and the instant system can best be seen by using the Examiners comments in section 3 of the subject office action as a template. The elements of the claim 1 are compared with the *Evans '820* reference using teaching cited by the Examiner.

> 1. A method for determining a property of a material, comprising the steps of:
> (a) inducing, within said material, gamma radiation comprising energies greater than about 3 MeV;

Examiner's references: Abstract, lines 1-7 and col. 8, lines 62 to col. 9, line 5.
Applicant's comments: There is no teaching of inducing gamma radiation in the abstract. Regarding col. 8, lines 62 to col. 9, line 5, measurement of gamma radiation in the 0.1 to 11 MeV range is used to derive information concerning elemental composition of the formation under investigation (see col. lines 9, 2-5).

> (b) measuring a first gamma ray spectrum and a second gamma ray spectrum resulting from said induced gamma radiation;

Examiner's references: None
Applicant's comments: There is teaching in *Evans '820* of measuring two gamma ray spectra at two different axial spacings using gamma ray detectors 66d and 84.

> (c) normalizing said first and said second gamma ray spectrum in a first energy region;

<u>Examiner's references</u>: Abstract, lines 7-8; col. 2, lines 41-65; col. 7, lines 19-49; and col. 10 lines 31-56.
<u>Applicant's comments</u>: There is no teaching of spectral measurement in the abstract. Near, intermediate and far spaced gamma ray *<u>and</u>* neutron detectors are discussed at col. 2, lines 41-65. The instant invention uses *<u>only</u>* gamma ray detectors. *Evans '820* does *<u>not</u>* teach *<u>normalizing</u>* two gamma ray spectra. *<u>Neutron</u>* detector normalization is taught at col. 2, lines 32-37. Gamma ray detector output is normalized for fluctuations in source *<u>neutron</u>* output (col. 2, lines 30-32). The Examiner seems to consider neutron and gamma ray detectors as equivalent. They are not equivalent, as is well established by the USPTO. Col. 7, lines 19-49 are devoted only to the discussion of *<u>neutron</u>* detectors. The instant invention uses only *<u>gamma ray detectors</u>*. Col. 10, lines 31-56 do not teach or suggest normalization of a first and a second *<u>gamma ray</u>* spectrum.

> (d) measuring down scatter gamma radiation in a second energy region of said normalized first and second gamma ray spectra; and

<u>Examiner's references</u>: None.
<u>Applicant's comments</u>: As discussed above, *Evans '820* does not teach *<u>gamma ray</u>* spectral normalization, thus does not teach measure of down scatter gamma radiation in a second region of *<u>normalized</u>* spectra.

> (e) determining said property from said measure of down scatter radiation.

<u>Examiner's references</u>: Abstract, lines 8-10; col. 2, lines 11-65; col. 4, lines 18-46; col. 9, line 6 to col. 10, line 46; and col. 12 lines 11-27.
<u>Applicant's comments</u>: There is no mention of down scatter radiation in the abstract or any of the cited material. Briefly, col. 2, lines 11-65 disclose detector functions as discussed previously, col. 4, lines 18-46 discuss basic concepts behind the *Evans '820* measurement, col. 9, line 6 to col. 10, line 46 discuss the function of gamma ray detector 66d as mentioned previously, and col. 12, lines 11-27 discuss the mechanics of fast neutron transport through material. *<u>None of the cited references even mentions down scatter radiation and the determination of a property from such radiation.</u>*

Regarding claim 3, the Examiner states that *Evans '820* discloses a first gamma ray spectrum (near spaced detector shown on Fig. 2 and near spaced detector 130 shown on Fig. 9. The detector 62 is a *<u>neutron detector</u>* (see col. 7, lines 1-49) and can not yield a first gamma ray spectrum. Again, the Examiner erroneously treats neutron and gamma ray detectors as being equivalent. The detector 130 is a gamma ray detector. Close inspection, however, shows that equations (1) through (9) contain a *<u>neutron source term</u>* that can fluctuate, as disclosed by *Evans '820.* Correction for source fluctuation is made with a measured neutron flux obtained with a *<u>neutron detector</u>* (see col. 13, lines 45-46). Stated another way, at least one of the previously discussed neutron detectors of the *Evans '820* system must be used to monitor neutron source output, and monitored neutron output is used to correct density measurements for adverse effects of neutron source fluctuation. The instant invention does not require a neutron detector, or the monitoring of neutron source output.

In view of the above comparisons, claims 1, and 3 are clearly not anticipated by *Evans '820.* Claims 2 and 4-7 are dependent upon claim 1. In view of the discussion related to claims 1, dependent claims 2 and 5, 6-7 are clearly not anticipated by *Evans '820.* The Examiner is respectfully requested to reconsider rejection of claims 1-7 35 U.S.C. § 102(b) as being anticipated by *Evans '820.*

Claims 8, 9, 11, 13-19, 21, and 24-26 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 3,864,569 to Jay Tittman (*Tittman*). Applicant respectfully traverses the rejections.

Tittman discloses a logging system for measuring density of earth formation penetrated by a well borehole. The *Tittman* logging instrument comprises a gamma ray source 21. The source is preferably cesium-137 (^{137}Cs) which emits gamma radiation at about 660 KeV or 0.660 MeV (see col. 3, lines 48-54). Two axially spaced gamma ray detectors are used to measure gamma radiation emitted by the source and *down scattered* by the formation. These measures of gamma radiation are combined to yield a measure of formation density

Tittman and the instant invention utilize completely different apparatus and methods to obtain formation density measurements. The *Tittman* system also has operational limitations while the instant invention can be operated in a much wider range of conditions, as will be discussed subsequently. The *Tittman* system obtains a formation density measurement by detecting gamma radiation that is emitted by a *gamma ray source* and is subsequently *down scattered* into the well borehole. The instant invention obtains a formation density measurement by detecting gamma radiation *induced* in formation by a *neutron source*. *Tittman* uses relatively low energy gamma radiation, which is less than the maximum source energy. The maximum source energy is about 0.660 MeV for the preferred cesium-137. The *Tittman* gamma ray source and two axially spaced gamma ray detectors are contained within an expandable, articulating pad that follows the wall of the borehole. The instant invention measures higher energy gamma radiation (e.g. 4.43 MeV). The *Tittman* system is limited to wireline logging applications. The instant invention can be uses both in wireline logging and in logging-while-drilling operations.

As in the first office action, the Examiner in paragraph 2, section 4 of the present office misquotes *Tittman* in citing at col. 2, lines 40-41 and col. 3, lines 49-54, that *Tittman* discloses an apparatus for measuring a property of material, comprising a *neutron* source. *Tittman* clearly discloses a *gamma ray* source. The Examiner is apparently treating neutron and gamma ray sources as *equivalent*, as she has treated neutron and gamma ray *detectors* as equivalent. *Neutron and gamma ray sources are not equivalent*, as is well established by the USPTO. *Tittman* employs a *gamma ray* source, and the instant invention employs a *neutron* source.

Regarding claims 8, 9, 11, and 13-17, independent claims 8 clearly recites inducing gamma radiation by means of a *neutron* source at element (a), and detecting gamma radiation *induced* by the *neutron* source at elements (b) and (c). Again note that col. 2, line 41 specifically recites that the *Tittman* tool contains a *gamma ray* source. Furthermore, col. 3, lines 49-54 specifically recite a ^{137}Cs gamma ray source.

Independent claim 8 is, therefore, clearly distinguished over *Tittman*. Claims 9, 11, 13-17, which depend upon independent claim 8, are also clearly distinguished over *Tittman*.

Regarding claims 18, 19, 21, and 24-26, independent claim 18 clearly recites a neutron source at element (a). Again, the *Tittman* tool comprises a *gamma ray* source. Claim 18, and dependent claims 19, 21, and 24-26 are therefore clearly distinguished over *Tittman*.

Regarding claims 17 and 26, the Examiner states in section 4 of the office action that

> "Tittman does not expressly disclose conveying apparatus used to obtain said measure of said property within said borehole by means of a drill string."

The Examiner goes on to say:

> "It is, however, considered inherent that Tittman obtains said measure of said property within said borehole by means of a drill string (see Col. 1. line 61 to col. 2, line 2 and col. 3, lines 26-33), because such element is known to be necessary in order that the drill bit forms the borehole through earth formations as the drill string and the bottom hole assembly turn."

The Examiners conclusion is flawed. First, the discussion in col. 1, line 61 to col. 2, line 2 is in the "Background" section of the disclosure and reviews for those skilled in the art the basic principles of *Tittman's* "gamma-gamma" density logging system. Briefly, these basic principles are (a) bulk density (the parameter of interest) is approximately the same as electron density (the parameter measured by the *Tittman* tool) for low Z elements commonly found in earth formations, and (b) measurements made in high Z materials (such as barite, which is used in drilling mud and which serves to lubricate the drill bit) cause erroneous bulk density readings. Col. 3, lines 26-33 just restates the problem resulting from mudcake of high barite content formed by the drilling fluid. The fact that *Tittman* mentions the words "drill bit" in the "Background" can not be construed as teaching measurement-while-drilling. The Examiner has taken the words "drill bit" completely out of context. How can measurement-while-drilling be taught by *Ttittman* when the words "drill bit" or "drill-string" or "measurement-while-drilling" or "logging-while-drilling" *do not even appear* in the "Summary of the Invention" or in the "Description of the Preferred Embodiments"? Applicant does not contest that both the *Tittman* system and the instant invention operate in a well borehole *drilled* using a drill bit. Applicant does, however, strongly contest the Examiner's reasoning that the *Tittman* system can be used as a measurement-while-drilling tool because it is operable in a well borehole drilled with a drill bit. The *Tittman* system can be operated in a borehole only *after* it has been drilled. The instant invention can operate in a bore *during* the drilling of the borehole and also *after* the borehole has been drilled.

Still referring to claims 17 and 26, a cursory inspection of the *Tittman* device (as shown in Fig. 1) will lead anyone skilled in the art to the obvious conclusion that (a) if

such a device were mounted on a drill string, and (b) the drill string were rotated to advance the borehole, then (c) the pad would immediately be "sheared" off and the system would be <u>inoperable</u>. It is well know in the field of while-drilling that pad-type devices are not operable in such applications. The instant logging tool is <u>not</u> a pad type device, and is therefore applicable to drill string conveyance and logging-while-drilling applications. Both wireline and logging-while-drilling embodiments of the instant logging system are discussed in detail in the instant specification.

In view of the discussion above, claims 17 and 26 are still further distinguished over *Tittman*, in addition to being dependent upon claims 1 and 18, respectively, which are clearly distinguished over *Tittman* as discussed previously.

In view of the above discussion, the Examiner is respectfully requested to reconsider rejection of claims 8, 9, 11, 13-19, 21, and 24-26 under 35 U.S.C. § 102(b) as being anticipated by *Tittman*.

<u>Claim Rejections Under 35 U.S.C. § 103(a)</u>

Claims 10 and 22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Tittman* in view of U.S Re. 36,012 to William A. Loomis et al (*Loomis*). Applicant respectfully traverses the rejections.

Loomis discloses a logging system that is designed to measure a variety of formation parameters, including density and porosity, by detecting neutron and gamma radiation induced within the formation by a neutron source. Gamma radiation up to 10 MeV is measured. A bottom hole assembly 36 houses a neutron accelerator type source 58 and clusters of axially spaced detectors comprising both neutron and gamma ray detectors (e.g. 66a, 66b, 66c and 66d). The bottom hole assembly also includes a <u>*neutron*</u> detector 62, which responds primarily to the accelerator output (see col. 6, lines 53-58). Such a detector is commonly referred to a neutron source monitor. Response of the <u>*neutron*</u> source monitor 62 is used to correct or "normalize" the measured responses of the other detectors for variations in neutron output from the accelerator neutron source in order to obtain accurate determination of formation parameters of interest.

Claim 10 (dependent upon claim 8 and intervening claim 9) and claim 22 (dependent upon claim 18) recite the use of first and a second <u>*gamma radiation*</u> spectra energy regions of about 3 MeV to about 7 MeV, and from about several hundred keV to about 3 MeV, respectively, to obtain a measure of density. The Examiner states in section 6 of the office action that it would have been obvious to one of ordinary skill in the art to modify the *Tittman* method to include (a) a first energy ranging from about 3 MeV to 7 MeV, and a second energy region ranging from about several hundred keV to about 3 MeV, as taught by *Loomis*. <u>*This is not technically possible*</u> since the *Tittman* uses a gamma ray source (preferably ^{137}Cs) with a maximum energy of about 0.660 MeV. Stated another way, there is no radiation produced by the *Tittman* system above 0.660 MeV, thus measurements in an energy region between 3 MeV and 7 MeV would be null and meaningless.

Claim 20 recites

20. The apparatus of claim 18 wherein said induced gamma radiation comprises energies greater than about 3 MeV.

Again, using the energy range of about 3 MeV from *Loomis* with the *Tittman* system would be meaningless since there is no radiation produced by the *Tittman* system above about 0.660 MeV.

Recall that the instant invention requires *no neutron measurements*. No monitoring of neutron source output is required. *No neutron detectors are recited*. No accelerator monitor is recited. Any hypothetical combination of the system of *Tittman* with the system of *Loomis* would include a plurality of neutron radiation detectors, a plurality of gamma radiation detectors, and a neutron monitor detector 62. The hypothetical combination comprises more elements of differing types than required by the instant invention. The hypothetical combination would also require more data processing steps than the instant invention.

In view of the above discussion, claims 10, 20 and 22 are clearly patentable over *Tittman* in view of *Loomis*. The Examiner is respectfully requested to reconsider rejection of claims 10, 20 and 22 under 35 U.S.C. § 103(a) as being unpatentable over *Tittman* in view if *Loomis*.

Claims 12 and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Tittman* in view of U.S 5,767,510 to Michael L. Evans (*Evans '510*). Applicant respectfully traverses the rejections.

Evans '510 discloses a logging system comprising a Californium-252 *neutron* source. *Tittman* discloses a logging system comprising a *gamma ray* source.

There is *no teaching or motivation* in the prior art to suggest the use of the *neutron* source of *Evans '510* in a logging system designed to use a *gamma ray* source, such as the pad type density logging system of *Tittman*. Furthermore, the use of the neutron source of *Evans* in the gamma ray logging system of *Tittman* would be *inoperable*, since *Tittman* determines density using gamma radiation *down scattered* from a relatively low energy gamma ray source such as ^{137}Cs. Detector collimation, pad design, detector energy biasing, and system calibration of the *Tittman* logging are all designed to measure this relatively low energy *down scatter* gamma radiation. The substitution of the *Evans '510* Californium-252 neutron source for the *Tittman* gamma ray source would produce neutron and neutron induced gamma radiation fluxes, at the *Tittman* detectors, which would not meet design criteria of the *Tittman* system and which the *Tittman* system could not measure and process. As a result, no measure of formation density could be obtained using a combination of *Tittman* and *Evans '510*. Claims 12 and 23 are, therefore, clearly patentable over *Tittman* in view of *Evans '510*. In view of the above discussion, the Examiner is respectfully requested to reconsider rejection of claims 12 and 23 under 35 U.S.C. § 103(a) as being unpatentable over *Tittman* in view if *Evans '510*.

Claims 27-29 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Tittman* in view of U.S Re. 36,012 to William A. Loomis et al (*Loomis*). Applicant respectfully traverses the rejections.

Once again, the Examiner misquotes Tittman. The *Tittman* system used a gamma ray source and not a neutron source. An examination of only element (a) of claim 27 clearly shows that *Tittman* is *misquoted* and can not be used as grounds for rejection. Referring to the preamble and element (a) of claim 27:

> 27. A method for determining bulk density of an earth formation penetrated by a borehole, the method comprising the steps of:
>
> (a) inducing gamma radiation within said formation by means of a *neutron* source;

Examiner's references: col. 2, lines 42-49 and col. 3, line 65 to col. 4, line 53.
Applicant's comments: Regarding col. 2, lines 42-49, line 42 clearly recites "The tool contains a *gamma ray* source". Col. 3, line 65 to col. 4, line 53 discloses various components of the apparatus, and the effects of "high Z" materials discussed previously. There is *no* mention of a neutron source, simply because none is taught by *Tittman*.

Independent claims 28 and 29 both recite a *neutron source* at elements (a). As in the discussion of claim 27, *Tittman* teaches *only* the use of a *gamma ray* source.

There is no *motivation* for a combination of *Tittman* and *Loomis*, and any type of hypothetical combination would be *inoperable*, for reasons detailed above in the discussion of claims 10, 20 and 22. Stated simply, a system based upon a gamma ray source (*Tittman*) and a system based upon a neutron source (*Loomis*) are *not* combinable. The Examiner is respectfully requested to reconsider rejection of claims 27-29 under 35 U.S.C. § 103(a) as being unpatentable over *Tittman* in view if *Loomis*.

The Examiner is respectfully requested to consider the above remarks and to allow pending claims 1-29 as filed.